

REMARKS

The Final Office Action mailed March 1, 2006, has been received and reviewed. Claims 10 through 31 are currently pending in the application. Claims 10 through 31 stand rejected. Applicant proposes to amend claim 10. No new matter is added. Reconsideration is respectfully requested.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Applicant's admitted prior art in view of U.S. Patent No. 4,080,619 to Suzuki

Claims 10 through 19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Applicant's admitted prior art in view of Suzuki (U.S. Patent No. 4,080,619). Applicant respectfully traverses this rejection, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

Suzuki discloses methods of making transistors including providing a structure including an original substrate 1 having an N type region thereon 2 and a P type base region 3 selectively grown on the N type region 2. (Suzuki, FIG. 3, col. 2, lines 45-53). An N type layer 4 is grown deposited and three layers of polycrystalline silicon (22, 23, 24) are deposited thereon. (Suzuki, col. 2, lines 51-52, col. 4, lines 34-54, FIG. 3). Openings in the third layer of polycrystalline silicon 24 are formed with an etchant of HF, acetic acid and nitric acid. The second layer of polycrystalline silicon 23 is then etched with phosphoric acid using the opened third payer 24 as

an etching mask. (Suzuki, col. 4, lines 50-54). Applicant respectfully submits that Suzuki in view of the prior art fails to teach or suggest every element of claims 10-31 of the presently claimed invention.

By way of contrast with Suzuki and the prior art, claim 10 of the presently claimed invention recites a “method of removing oxide polymer and metal polymer from a contact opening in a dielectric layer having an underlying metal-containing layer on a semiconductor substrate, the method comprising applying a solution consisting essentially of a nitric acid solution on the contact opening followed by a phosphoric acid solution dip.” Support for the amendment can be found throughout the as-filed specification, for example, page 5, lines 9-15.

Applicant respectfully submits that Suzuki fails to teach or suggest “removing oxide polymer and metal polymer from a contact opening in a dielectric layer having an underlying metal-containing layer on a semiconductor substrate, the method comprising applying a solution consisting essentially of a nitric acid solution on the contact opening followed by a phosphoric acid solution dip.” Instead, Suzuki lacks any disclosure about applying any solution to *a contact opening* in a dielectric layer having an underlying metal-containing layer. Suzuki utilizes etchants to create openings in polycrystalline silicon layers, not to remove residue from already formed openings. Additionally, Suzuki teaches an etchant wherein hydrogen fluoride, acetic acid and nitric acid are mixed which is not “applying a solution consisting essentially of a nitric acid solution” as recited by the presently claimed invention.

No motivation exists within Suzuki to utilize the etchant for any purpose other than to remove polycrystalline silicon layers. The admitted art lacks any teaching or suggestion of using nitric acid to remove residue in a contact opening. Thus, no motivation exists in the prior art or Suzuki for “applying a solution consisting essentially of a nitric acid solution” followed by a phosphoric acid dip on an already formed contact opening. Accordingly, Suzuki in view of the admitted art cannot render claim 10 of the presently claimed invention obvious and claim 10 is allowable. Reconsideration and withdrawal of the rejection is requested.

Claims 11-20 are each allowable as depending, either directly or indirectly, from allowable claim 10. Reconsideration and withdrawal of the rejection is requested.

Claims 18, 19 and 20 are further allowable as Suzuki fails to teach or suggest that the phosphoric acid dip includes a fluoride-containing component, or that the fluoride-containing component includes hydrofluoric acid or ammonium fluoride.

By way of contrast with the prior art and Suzuki, claim 21 of the presently claimed invention recites “[a] method of fabricating a via in a dielectric layer and an underlying barrier layer for a semiconductor device, comprising: forming a partial via in the dielectric layer to expose at least portion of the barrier layer; cleaning the partial via with a phosphoric acid-containing solution; etching the barrier layer after the cleaning to form a full via having a metal containing trace on a bottom surface thereof; and applying a nitric-acid containing solution to the full via.” Applicant respectfully submits the combination of the admitted prior art and Suzuki fails to teach or suggest every element of the presently claimed invention.

The admitted prior art teaches a two-step etch process and applying phosphoric acid within the completed via. Suzuki teaches etching an opening in a first silicon layer with a mixture of hydrogen fluoride, acetic acid and nitric acid followed by a etching an opening in a second silicon layer with phosphoric acid. (Suzuki, col. 4, lines 50-54). However, the combination of references fail to teach or suggest “forming a partial via in the dielectric layer to expose at least portion of the barrier layer; cleaning the partial via with a phosphoric acid-containing solution; etching the barrier layer after the cleaning to form a full via having a metal containing trace on a bottom surface thereof; and applying a nitric-acid containing solution to the full via.” Instead, the admitted art only teaches a single phosphoric acid dip within the completed via while Suzuki essentially teaches the opposite method – a first etch mixture of hydrogen fluoride, acetic acid and nitric acid followed by a etching an opening in a second silicon layer with phosphoric acid. *Id.* Further, as stated, Suzuki fails to teach or suggest applying solutions within a completed via and instead teaches etchant solutions to create vias.

Accordingly, Suzuki in view of the admitted art cannot render claim 21 of the presently claimed invention obvious and claim 21 is allowable. Reconsideration and withdrawal of the rejection is requested.

Claims 22-31 are each allowable as depending, either directly or indirectly, from allowable claim 21. Reconsideration and withdrawal of the rejection is requested.

Claims 29, 30 and 31 are further allowable as Suzuki fails to teach or suggest that the phosphoric acid dip includes a fluoride-containing component, or that the fluoride-containing component includes hydrofluoric acid or ammonium fluoride.

Obviousness Rejection Based on Applicant's admitted prior art in view of Japanese Patent No. JP 05-041485 to Yamada Osamu

Claims 10 through 31 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Applicant's admitted prior art in view of Yamada Osamu (Japanese Patent No. 05-041485). Applicant respectfully traverses this rejection, as hereinafter set forth.

Osamu discloses a method of improving reliability of a MOS semiconductor element. The method includes covering a substrate surface (except a faulty unit element 15) with a protective film 9. (Osamu, Abstract). The silicon substrate is etched with phosphoric acid and nitric acid to remove the source electrode 7. (Osamu, paragraph [0012]). Then, the PSG film 51 on the gate electrode 6 is etched with HF buffer. An etchant comprising nitric acid, HF and acetic acid is used to remove the gate electrode 6 and form an opening 10. *Id.* Applicant respectfully submits that the proposed combination of the Osamu and the prior art fail to teach or suggest every element of claim 10 of the presently claimed invention.

By way of contrast with Osamu, claim 10 of the presently claimed invention recites a "method of removing oxide polymer and metal polymer from a contact opening in a dielectric layer having an underlying metal-containing layer on a semiconductor substrate, the method the method comprising applying a solution consisting essentially of a nitric acid solution on the contact opening followed by a phosphoric acid solution dip." Applicant respectfully submits that Suzuki fails to teach or suggest "removing oxide polymer and metal polymer from a contact opening in a dielectric layer having an underlying metal-containing layer on a semiconductor substrate, the method comprising applying a solution consisting essentially of a nitric acid solution on the contact opening followed by a phosphoric acid solution dip."

Instead, Osamu fails to teach or suggest a nitric acid solution dip *followed by a phosphoric acid solution dip* as recited in claim 10. At best, Osamu teaches a first etchant containing both phosphoric acid and nitric acid followed by a nitric acid solution containing etchant which is not the method comprising “applying a solution consisting essentially of a nitric acid solution on the contact opening followed by a phosphoric acid solution dip” as recited in claim 10 of the presently claimed invention. (Osamu, Abstract).

Osamu utilizes etchants to remove silicon layers and the gate electrode. No motivation exists within Osamu to utilize the etchant for any purpose other than to remove silicon layers and the gate electrode. The admitted art lacks any teaching or suggestion of using nitric acid to remove residue in a contact opening. Thus, no motivation exists in the prior art or Osamu for “applying a solution consisting essentially of a nitric acid solution” followed by a phosphoric acid dip on an already formed contact opening. Accordingly, Osamu in view of the admitted art cannot render claim 10 of the presently claimed invention obvious and claim 10 is allowable. Reconsideration and withdrawal of the rejection is requested.

Claims 11-20 are each allowable as depending, either directly or indirectly, from allowable claim 10. Reconsideration and withdrawal of the rejection is requested.

Claims 18 -20 are further allowable as Osamu fails to teach or suggest that the phosphoric acid dip includes a fluoride-containing component, or that the fluoride-containing component includes hydrofluoric acid or ammonium fluoride. At best, Osamu discloses a separate HF etch or a second etch wherein the second nitric acid containing solution includes hydrofluoric acid. (Osamu, Abstract).

By way of contrast with Osamu, independent claim 21 of the presently claimed invention recites a “method of fabricating a via in a dielectric layer and an underlying barrier layer for a semiconductor device, comprising: forming a partial via in the dielectric layer to expose at least portion of the barrier layer; cleaning the partial via with a phosphoric acid-containing solution; etching the barrier layer after the cleaning to form a full via having a metal containing trace on a bottom surface thereof; and applying a nitric-acid containing solution to the full via.” Applicant respectfully submits that the proposed combination of Osamu and the prior art fails to teach or suggest every element of claim 21 of the presently claimed invention.

The proposed combination fails to teach or suggest “forming a partial via in the dielectric layer to expose at least portion of the barrier layer; cleaning the partial via with a phosphoric acid-containing solution.” The admitted art does not teach or suggest cleaning a partial via, but only that the full via may be cleaned with phosphoric acid. Specification, page 4, lines 10-15. Osamu lacks any teaching or suggestion that phosphoric acid may be used to clean a partial via exposing at least a portion of a barrier layer. Instead, Osamu discloses a solution containing both phosphoric acid and nitric acid to etch a substrate, not to clean an existing via. Mixtures of phosphoric acid and nitric acid are insufficient to remove metal polymer. (Specification, page 8, lines 4-5). Further, the proposed combination fails to teach or suggest “etching the barrier layer after the cleaning to form a full via having a metal containing trace on a bottom surface thereof; and applying a nitric-acid containing solution to the full via.” Instead, Osamu fails to disclose any cleaning after forming opening 10 and discloses a nitric-acid containing solution to remove gate electrode 6. (Osamu, paragraph [0012]). The proposed combination lacks any teaching or suggestion of applying a phosphoric acid containing solution to a partial via, etching the partial via to form a full via and applying a nitric acid containing solution to the full via. No motivation exists in either the prior art or Osamu applying a phosphoric acid containing solution to a partial via, etching the partial via to form a full via and applying a nitric acid containing solution to the formed, full via. Accordingly, Osamu and the prior art cannot render claim 21 of the presently claimed invention obvious and claim 21 is allowable. Reconsideration and withdrawal of the rejection is requested.

Claims 22-31 are each allowable as depending, either directly or indirectly, from allowable claim 21. Reconsideration and withdrawal of the rejection is requested.

Claims 29 -31 are further allowable as Osamu fails to teach or suggest that the *phosphoric acid dip* includes a fluoride-containing component, or that the fluoride-containing component includes hydrofluoric acid or ammonium fluoride. At best, Osamu discloses a separate HF etch or a second etch wherein the second nitric acid containing solution includes hydrofluoric acid. (Osamu, Abstract).

ENTRY OF AMENDMENTS

The proposed amendments to claim 10 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search. Finally, if the Examiner determines that the amendments do not place the application in condition for allowance, entry is respectfully requested upon filing of a Notice of Appeal herein.

CONCLUSION

Claims 10-31 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,



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